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Agricultural Research

Safeguarding the World's Seeds

Henry L. Shands, USDA's coordinator of the National Plant Germplasm System (NPGS) discusses the United States' efforts to maintain a permanent, living collection of plants and seeds for the future.

Ag. Res. Questions have been raised in the media and even in the courts about the way the United States maintains its stock of plant genetic material. How do you see our responsibility?

Shands. Genes in seeds and plants, usually referred to by scientists as germplasm, are clearly a precious global resource. As such, we have an international obligation to do our part to manage it carefully and we do this through the National Plant Germplasm System, a partnership of federal and state agencies and private industry which has grown steadily since its inception in the 1940's.

Ag. Res. Then saving seeds for the future should be an international concern?

Shands. Yes, besides our own system, the International Board for Plant Genetic Resources has sponsored many plant expeditions and helped establish gene banks in many developing countries. The board has provided seed of rice, sorghum, millet, beans, corn, and some less popular crops to the NPGS for use and safekeeping at our National Seed Storage Laboratory in Fort Collins, CO. It turns seed over to the U.S. system with the understanding that it will be freely available to scientists worldwide.

Ag. Res. There has been criticism of cropping patterns in the United States in that only a few varieties of each major crop are grown. Does this tend to narrow the genetic base for these crop plants?

Shands. Definitely. However, the underlying diversity of plant material that was used to develop a new variety is still being maintained. For example, the short-straw wheat germplasm developed in the 1960's that contributed to the worldwide Green Revolution was based in part on Gaines, a high-yielding, white wheat bred for U.S. farmers. Gaines, in turn, carries genes from a wheat brought from Japan in 1946 by S.C. Salmon of USDA. And that original germplasm is still being maintained in the NPGS.

Ag. Res. The Plant Variety Protection Act of 1970 allows plant breeders to patent their new varieties. Does this limit germplasm available to developing countries?

Shands. Not necessarily. Nonpatented plant material is available from the approximately 40 NPGS collections without charge. In 1985, the most recent year for which we have statistics, over 100,000 samples were given to breeders and researchers in 123 countries. And even protected germplasm can be legally used for research and development.

It's a natural economic occurrence that when a high-yielding variety comes along, farmers want to grow it. We want to be very responsible about the effect of this, and we, as well as other nations, should take steps to preserve the older varieties before getting into large-scale production of more genetically uniform crops. Not only should a diverse mixture of genes be saved for yield improvement reasons but as a sort of biological insurance policy against a crop disaster.

Ag. Res. How does this kind of insurance work?

Shands. It would be in a situation where a pest adapts rather suddenly and begins attacking what had been a resistant crop variety. Here in the United States, as recently as 1970, southern leaf blight destroyed an estimated 15 percent of the corn crop. This blight wasn't even considered a problem a year or so before. If the germplasm system has a broad diversity of genes in a particular crop, it is much more likely that all of the commercial varieties won't be uniform. We also stand a better chance of developing a new resistant variety quickly.

Ag. Res. You mentioned plant explorations earlier; are they still important these days?

Shands. Yes. Although USDA has sponsored about 100 plant expeditions since World War II, it seems we can never do enough. Right now we are increasing our budget for explorations so that we can ensure the widest possible diversity within our germplasm collections.

Ag. Res. How do plant explorers know where to look if they want a plant that will resist a disease that may not appear for 10 to 25 years?

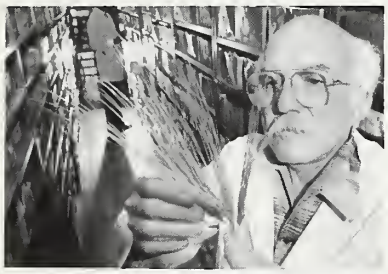
Shands. They start by looking in the native homelands of the crop they are investigating. These points of origin, called centers of diversity, hold a great genetic diversity in species we now use for crops. Often the pest that is attacking a crop here in the United States evolved in tandem with that crop at its center of diversity. Wheat, for example, probably has its origin in the western part of Central Asia. So if we are looking for resistance to a particular pest, say the Hessian fly, we would expect the best place to look would be Afghanistan, Iraq, Turkey, and elsewhere in the region.

Ag. Res. Hasn't the NPGS already collected and stored these primitive varieties?

Shands. We have a nice collection from some regions. From other areas, it's a different story. One thinks of China and its borders being closed for years following World War II, for example. Overall, there's still a lot of work to be done. — *Interview by* **Stephen Berberich,** ARS.

Agricultural Research

Cover: Times have changed since this catalog was published in 1909. But one thing that hasn't changed, except to become more critical, is the need to preserve precious seeds and other living plant material. Today, the world's largest gene bank for plants uses computers to keep track of their billions of seeds and other collections. Story begins on page 6. (USDA's National Agricultural Library at Beltsville, MD, has about 160,000 nursery and seed trade catalogs in their Special Collections.) (PN 7236)



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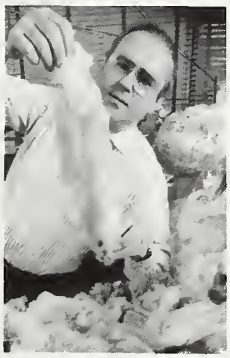

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Trash and Snow Blankets in Minnesota

Cornstalks left on a field in the fall will later help form a snow blanket to warm land even in the worst Minnesota winter.

An Agricultural Research Service study in Morris, MN, shows more snow trapped and, consequently, subsurface frost disappearing first on unplowed, cornstalk-littered fields (no-till).

With no-till, farmers do not plow after harvest. When it comes time to plant the next crop, they use machinery designed to plant seeds in narrow slots cut in the soil, right through the residue of the previous crop.

The study is comparing no-till plots with land cleared in the fall, some with the broad soil-turning blades of a moldboard plow and some partially cleared of residue with narrow chisel blades.

On this Midwest farm, snow trapped by standing crop stubble will help insulate the soil and reduce frost depth. (NE-2256)

Data averaged for the first 3 years of the study shows soil in no-till plots thawed anywhere from 10 to 30 days earlier than soil in other plots.

George R. Benoit, an ARS soil scientist in Morris, says, "Data gathered the winter before last tends to verify these results. And the unusually warm winter of 1986-87 has emphasized that the variation in frost depth is associated with amounts of snow cover: With very little snow cover on any of the plots, frost depth was essentially the same in all of them."

The exceptionally cold 1983-84 winter had the greatest snowfall and the shallowest frost depth under no-till, about 14 inches, compared with a frost depth of about 40 inches for the rest of the land. On no-till plots, the frost disappeared by the end of March, much earlier than elsewhere.

All plots, planted to nothing but corn year after year, were tested once a week for frost depth, snow depth, and soil water.

The study results show that Snow Belt farmers who want their soil to warm up earlier in the spring would do well to leave crop residue on the ground to trap snow.

The warmer soil with no-till "means you can plant such crops as spring wheat earlier," says Benoit. — By **Don Comis,** ARS, and **Betty Solomon,** ARS (retired).

George R. Benoit is with the USDA-ARS North Central Soil Conservation Research Laboratory, North Iowa Ave., Morris, MN 56267. ♦

Fungus Helps Soybeans Beat Drought

Deliberately injecting the soil with a fungus may be good insurance against drought for soybean growers.

James R. Ellis, a microbiologist with the USDA Agricultural Research Service in Lincoln, NE, says that VAM (vesicular arbuscular mycorrhizal) fungus makes water uptake easier for plants under drought conditions.

VAM lives in the soybean roots where it manufactures growth-producing hormones and takes up nutrients that stimulate root growth. A VAM-infected root system is larger and extends farther into the soil to reach deeper moisture.

"The larger root system also helps a plant better utilize soil nutrients, such as phosphorus," Ellis says.

Ellis infected soybeans with the VAM fungus in greenhouse studies done in cooperation with the Nebraska Agricultural Experiment Station in Lincoln.

To create stress, Ellis withheld water for 9 days during the pod elongation stage of the plant's growth. "We saw the positive effect the fungus had on drought-stressed plants," Ellis says. "Yield was 50 percent higher in plants infected with VAM than in noninfected plants because fewer pods were aborted because of a lack of water."

Although field studies must follow to confirm the greenhouse experiment, the results of this study show potential benefits for soybeans in dry climates.

In earlier research, Ellis found the same beneficial effect against drought from VAM fungus living in the roots of wheat plants.

Ellis says that someday ARS may be able to recommend farming practices that will enhance the growth of the fungus and use its natural ability to increase yields. — By **Linda Cooke,** ARS.

James R. Ellis is in USDA-ARS Soil and Water Conservation Research, East Campus, University of Nebraska, Lincoln, NE 68583. ♦

Vitamin D Hormone May Heal Psoriasis

A potent hormone that is a form of vitamin D may be useful in treating psoriasis, scientists at USDA's Agricultural Research Service Human Nutrition Research Center on

Aging at Tufts University have found.

"Out of 15 patients who had been unresponsive to other therapies, 80 to 85 percent had a good to excellent reaction to the substance," says Michael F. Holick, director of the Vitamin D and Bone Metabolism Laboratory at the center in Boston.

In one case, Holick says, large patches of scaly skin on a patient's legs and feet began to clear dramatically after treatment with the hormone. After 6 weeks of taking a hormone pill once a day, the scaling decreased. After 8 weeks, there was a significant decrease in skin redness and a clearing of lesions. This person had suffered from the skin disease for 20 years. Other patients with less severe psoriasis had essentially complete clearing of lesions after 6 weeks of daily treatment with an ointment containing the hormone.

Not much is known about the cause of psoriasis, which affects 1 to 3 percent of the world's population. It is thought to be tied to a disruption in normal cell growth, which results in a proliferation and buildup of cells.

Holick and his colleagues at the research center, Ellen Smith and Stephanie Pincus, M.D., chose to test the vitamin D hormone because years of research had shown that it would decrease the proliferation of cells in the outermost layer of skin.

"More work needs to be done, but the preliminary results are very promising," Holick says. "Some patients had complete clearing of their lesions without any adverse side effects that we can determine to date."

Individuals with psoriasis who are interested in participating in future studies should send a self-addressed stamped envelope to Michael F. Holick, USDA-ARS Human Nutrition Research Center on Aging, 711 Washington Street, Boston, MA 02111. — *Condensed from a December 18, 1986 Tufts Journal article by* ***Deborah Halber.*** ♦

Starch Goes Straight To Help Diabetes Victims

All starch is not equal when it comes to controlling blood glucose and insulin levels, according to an Agricultural Research Service nutritionist.

Starch occurs naturally as amylose—a straight chain of glucose molecules—or as amylopectin, a branched chain of glucose. A recent 10-week study confirmed earlier findings that amylose is better than amylopectin at keeping blood glucose and insulin levels in check, says Kay Behall with the agency's Beltsville (Maryland) Human Nutrition Research Center.

When the 12 men in the study ate a meal of crackers specially made with a high-amylose content (70 percent), their blood glucose and insulin levels were significantly lower than after eating the high-amylopectin crackers. "The whole effect is to slow digestion of starch," she says. "Glucose from the meal is being absorbed at a more even rate."

Behall says that foods high in amylose starch could benefit obese people, diabetics, and those in danger of becoming diabetic, such as those with a family history of the disease. The main obstacle to putting this information to use is that the starch composition of most foods is unknown.

High-amylose foods might also help prevent heart disease, she adds. The high-amylose crackers significantly reduced average blood levels of triglycerides (fats) in the volunteer subjects, a direct result of the reduced insulin levels. Chronically high insulin and triglyceride levels are both considered risk factors for heart disease. — By **Judy McBride,** ARS.

Kay Behall is at the USDA-ARS Beltsville Agricultural Research Center-East, Room 304, Bldg. 307, Beltsville, MD 20705. ♦

New Lettuce Resists Major Disease

A new iceberg lettuce variety will help California growers ward off losses to big vein, a disease that may spoil the taste of the lettuce.

Edward J. Ryder, the USDA Agricultural Research Service geneticist who developed the lettuce and named it Pacific, says the variety is resistant to big vein, one of the crop's major diseases.

Big vein is spread by a fungus that feeds on the roots of the lettuce plant. Because there is no practical way to treat the disease, growers must rely on resistant varieties.

In infected plants, tissue around normally unobtrusive veins in leaves turns from a healthy green to a pale yellow. This makes the veins look bigger, even though they aren't actually enlarged by the infection.

The disease can also prevent lettuce from forming the normal round, tight head or delay growth so that farmers have to make another costly run through their fields to pick the slower developing heads.

Pacific is best-suited for the Salinas and Imperial Valleys of California, where 40 percent of the nation's lettuce crop is grown.

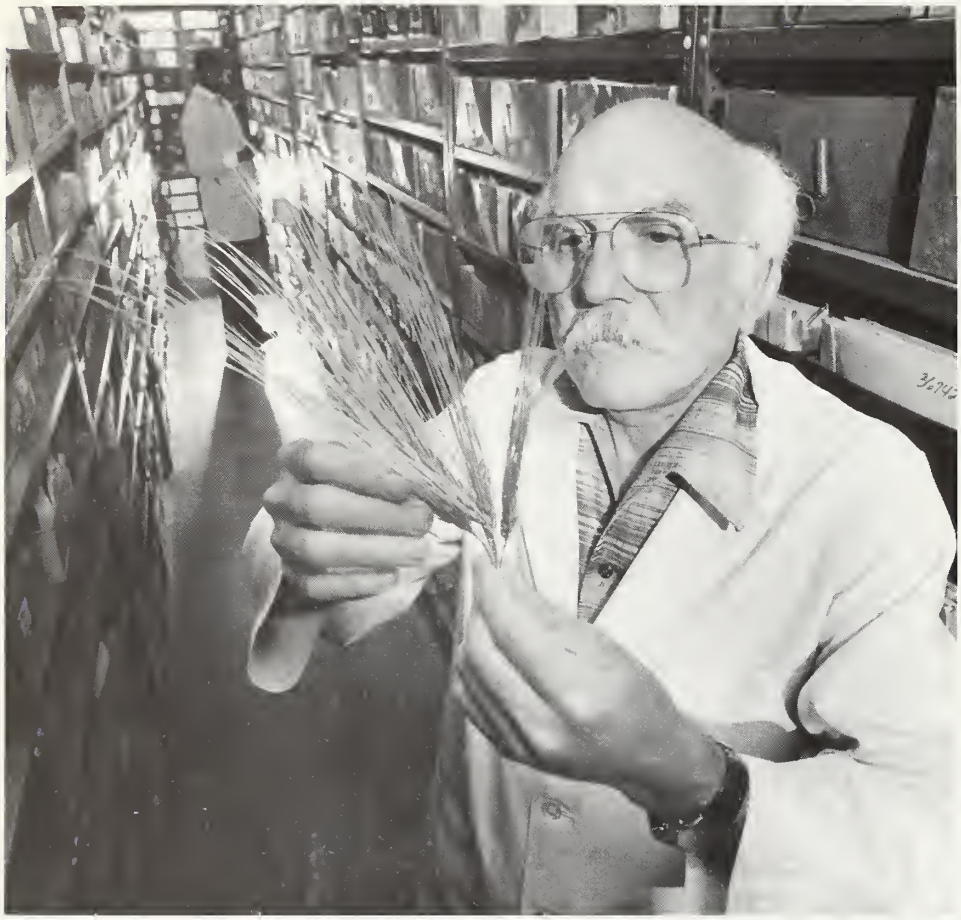
Seed companies in the United States have the option of selling the seed as is to commercial lettuce growers or developing additional varieties from it.

In the series of three iceberg lettuce varieties that Ryder and colleagues have developed so far to counteract big vein, Pacific is the most resistant to the disease.

Says Harold Bradshaw, manager of the California lettuce growers group that funded part of the research, "We're excited about this new variety; we think its going to be good." — By **Marcia Wood,** ARS.

Edward J. Ryder is at the U.S. Agricultural Research Station, 1636 East Alisal St., Salinas, CA 93905. ♦

Preserving the Stuff of Life



Tim McCabe

David Smith, curator of the USDA National Small Grain Collection at Beltsville, MD, examines a barley sample. The Small Grain Collection has about 110,000 specimens of wheat, rice, barley, oats, rye, and other cereal crops gathered from around the world. (1185X1283-30A)

The wealth of valuable seeds and plants in U.S. plant gene banks is literally at the fingertips of the world. A computer database called Germplasm Resources Information Network (GRIN) offers information on plant genes, or germplasm, to any bona fide researcher.

GRIN is a computerized catalog of information on millions of seeds and plants and trillions of genes in USDA collections and many state and private collections.

After World War II, American scientists formed a national effort to preserve plant germplasm. They wanted to ensure that seed collections would not be lost when plant explorers, geneticists, and breeders lost funds, lost a technician, or retired. Putting the information on computer is the logical extension of that concern.

"It has already strengthened us enormously" says Henry L. Shands, who serves as USDA's coordinator of today's National Plant Germplasm System (NPGS). "This computer hub has improved our plant tracking systems for exploring, collecting, and evaluating germplasm. It links breeders directly into data on gene banks and permits ordering seed electronically from working collections across the nation."

The strength of the germplasm system, says George White, a USDA Agricultural Research Service plant introduction officer, is the dedication of its people. "Without the very careful attention to details of germplasm documentation and storage by hundreds of individuals at field locations, we could not have a computer database today," he says. (In White's office at Beltsville, Maryland, a large portrait of Frank N. Meyer—a picture of dedication—greets visitors. Meyer trekked through China on foot or oxcart for the first 15 years of the 20th century collecting rare and valuable plants.)

Today, as early this century, says Shands, national program leader for plant germplasm with ARS, "the mission of the national germplasm system is to protect plant genetic resources and to have a working collection for users, such as scientists.

The system provides accurate descriptions of plants that have been collected and preserved. It tries to hold onto the viability or strength of each seed, tissue, or whole plant in the collections by growing them periodically. The germplasm database includes information on both where a plant came from and its genetic potential."

Lately, says Shands, the germplasm system has taken the heat of serious criticism but benefited from it. The United States and other developed nations have been accused of being too self-serving in plant germplasm ownership, he says. And a few environmental groups in this country have said that the U.S. Department of Agriculture has been negligent as a steward of such a precious natural resource.

"The criticism was timely. It followed USDA budget increases for germplasm beginning in 1983," says Shands. "Increases that helped us answer criticism."

According to White, no foreign requests are ever denied, although some seeds do not reach their destinations because of quarantine rules in a requester's country. "Since 1975, the United States has given free, field-evaluated seeds and plants to scientists in about 120 countries each year," he says.

Today, the National Plant Germplasm System is the largest, most active gene bank system on Earth. Its location represents a great irony. No major crops are native to North America. This continent has given the world a few minor crops, including blueberries, cranberries, pecans, Jerusalem artichokes, and sunflowers.

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THE TEXAS DIPLOID ASIATIC COLLECTION (G. HERBACEUM)

TEXAS A1 #	SUF FIX	GRIN PREF	GRIN NUMBER	CULTIVAR OR COMMON NAME	ORIGIN COUNTRY	COLLECTOR AND YEAR	COLLECTOR NUMBER	LAST INCR
1	01	A1	1	YERLI-193	India			1971
2	01	PI	81838	BARD MESA 271	Soviet Union	TURKESTAN PBS 1929	#2929	1968
3	01	PI	152083		Soviet Union	TASHKENT BS 1946	#0686	1970
4	01	PI	167905		Turkey	J R HARLAN 1948		1968
5	01	PI	167906		Turkey	J R HARLAN 1948		1968
6	01	PI	167907		Turkey	J R HARLAN 1948		1970
7	01	PI	167908		Turkey	J R HARLAN 1948		1971
8	01	PI	167912		Turkey	J R HARLAN 1948		1971
9	01	PI	175456		Turkey	J R HARLAN 1949		1968
10	01	PI	175457		Turkey	J R HARLAN 1949		1971

A sample printout from the Germplasm Resources Information Network shows collection data for a cotton variety. Computers allow researchers to retrieve information in a matter of minutes or hours compared to the weeks it used to take them to sort through index cards.

"We now have a fine agriculture. One major reason is because explorers and collectors found and maintained the right seeds for our land," says Sam Dietz, research leader of the ARS Western Regional Plant Introduction Station at Pullman, WA. "GRIN is designed to give scientists a quantum leap in finding and using the right genes for the right job."

Consider the sheer magnitude of the data. In 17 USDA collections alone, there are nearly 500,000 genetically different kinds of seed samples, all packed in neat bags or tins in refrigerated rooms or "iced" in cryovats of liquid nitrogen.

Roughly a billion seeds fill one room of the USDA National Small Grain Collection at Beltsville. From that collection each year, nearly 200,000 samples of wheat, rice, barley, or oats are sent on request, free to scientists, over half in foreign countries. According to the International Board on Plant Germplasm Resources in Rome, Italy, 75 to 80 percent of all wheat seed exchanged in the world comes from this collection.

Established in 1957, the National Seed Storage Laboratory at Fort Collins, CO, is the "treasury of the NPGS," holding over 280,000 seed specimens in vaults for long-term storage. Included are complete backup collections, not only for U.S. collections, but for many of those in developing countries and centers of the Consultative Group of International Agricultural Research.

"Since 1975, the United States has given free, field-evaluated seeds and plants to scientists in about 120 countries each year."

George White, Plant Introduction Officer

Then, there are "seeds" of the fresh type. Eight National Clonal Germplasm Repositories from Oregon to Florida and Hawaii hold cuttings and whole fruit and nut plants of 20,000 genetically different types.

Shands says that GRIN is making it easier to share the wealth, "something a germplasm-poor continent should feel obligated to do." First, curators can better assess the value of their collection by printing reports on seed origins and botanical and agricultural characteristics.

"We also have a much easier time now evaluating plants for traits from leaf size to pest resistance," says Shands.

GRIN can display an average of 50 to 60 traits for each type of seed stored. Deitz illustrates the networks' power:

"We maintain a collection of over 10,000 beans. We have 36 traits recorded for each. If a scientist wrote, 'I want a white bean with early maturity time, resistance to curly top disease, less foliage so machine harvesters won't be jammed, and seven or eight other traits,' we'd look through 10,000 3x5 cards by hand. It would take weeks. Then, did we even find the right data? Did we copy all the six-digit plant introduction (PI) numbers correctly? Did the data get recorded correctly?

"With GRIN, those days are over. We finally have one complete listing of

Don Albern

At the clonal repository in Geneva, NY, horticulturist Philip Forsline checks the heavy-fruiting characteristics of a French-American grape hybrid. (1186X1216-16)

Jack Dykinga

Germination tests ensure the viability of seeds stored at the National Seed Storage Laboratory in Fort Collins, CO. Technician Mike Dideriksen examines seedlings. (0385X257-29A)

all the material in the system." (At Pullman and three other NPGS regional plant introduction stations, it now takes about two-thirds less time to process a request.)

However, germplasm stewards are quick to point out that a high-speed computer system, impressive numbers of seeds, and dedicated workers would all be superficial if the NPGS could not be used to solve agricultural problems.

Some of the most notorious problems for breeders are grain diseases. Dietz says that many diseases of wheat, barley, rice, and other grains "put pathologists on a merry-go-round. In no other area of plant sciences are our germplasm collections more important."

Those diseases are often caused by multirace pathogens. When a resistant variety is released to farmers, the pathogens usually evolve a new race which overcomes the resistance in about 5 years. Scientists must then find and breed a new resistance gene into the crop. The pathogen again overcomes the resistance changes, and again breeders have to find and incorporate a new gene.

Gene banks keep the pathologist one step ahead, but sometimes, thanks to a seed saved for a rainy day, a breeder buys some time out of the cycle. The best example, says Dietz, is a "trashy" wheat, called PI 178383, collected in Turkey in 1948.

"Thirty years ago in the Northwest, pathologists couldn't *buy* resistance to wheat bunt, a disease that produced copious dusty spores. It was so bad at times that they would ignite and blow up harvesting combines.

"Meanwhile, PI 178383 was an orphan wheat in cold storage. It was a tall plant that fell flat in the wind and rain. The plant also had poor milling and baking qualities. However, when finally tested, it resisted not only all predominant races of common bunt, but the worst races of dwarf bunt, and, could tolerate other major diseases. Now PI 178383 genes are in all the wheat grown in the Northwest."

Ten years ago, impressed with the impact of that one scraggly wheat, Washington State University agronomist C.F. Konzak and visiting Turkish scientist Basri Devezioglu used a computer to map the locations of all wheat

> ***"Before [the Germplasm Resources Information Network], we'd look through 10,000 3x5 cards by hand. It would take weeks. Then, did we even find the right data?"***
>
> Sam Dietz, research leader of the ARS Western Regional Plant Introduction Station, Pullman,WA.

samples collected in Turkey. The map showed hundreds of X's on the central plateaus where the terrain resembles U.S. wheat growing areas. However, only PI 178383 and 9 other samples of 50,000 total had been collected in the mountains of eastern Turkey. Leading wheat scientists could then judge by the map that more collecting in eastern Turkey was needed.

Similar success stories of plants saved for a rainy day are in every lab and greenhouse. The navel orange originated from a cutting brought by USDA from the Mediterranean basin in 1870.

Since before Frank Meyer, hundreds of federal, state, and private plant explorations and foreign exchanges have built the NPGS. The unofficial USDA policy on these explorations is to leave half of each seed sample collected with host scientists in their country.

"As a gift, germplasm is beautiful," says renowned ARS soybean breeder Richard Bernard. "When you give it, you keep it too." Bernard, who heads the Soybean Breeding and Production Laboratory at Urbana, IL, uses the computerized database to produce routine catalogs of his germplasm inventory. The catalogs are extremely useful to scientists outside of the United States who are not yet online with the computer. — By **Stephen Berberich,** ARS.

George A. White is at the USDA-ARS Germplasm Introduction and Evaluation Laboratory, Bldg. 001, Room 322, BARC-West, Beltsville, MD 20705. Henry L. Shands is with the USDA-ARS National Program Staff, Bldg. 005, Room 140, BARC-West, Beltsville, MD 20705. ♦

Jack Dykinga

Agronomist Phillip Stanwood and technician Lana Nelson inspect seed samples stored in liquid nitrogen at about -320°F. (0385X261-13)

Very Cold Storage Extends Seed Life

More than two-thirds of the seed now stored in temperature-controlled rooms could be stored for one-fourth the cost in liquid nitrogen, say scientists with the National Seed Storage Laboratory at Fort Collins, CO.

Much of the savings from cryopreservation—supercold storage at °320 F—accrues because seed life is extended. Therefore, fewer regrowings are needed to replenish seed when it begins losing its ability to sprout.

As part of a larger project to develop improved storage procedures for seed, pollen, plant buds, plant pieces, and even individual plant cells, the laboratory now has seed from 34 major crops stored in six 225-gallon nitrogen-filled vats. Total capacity of the 6 is 20,000 to 30,000 seed samples.

Scientists plan to test a half percent of these seeds each year to make sure good germination is maintained. — By **Dennis Senft,** ARS. ♦

Cleaning Wool's Reputation

Tim McCabe

Chemist William Marmer examines a wool sample scoured with supercritical carbon dioxide followed by carding and a cold water rinse. This experimental process is being studied as a possible way to both clean the wool and purify wool grease (a source of lanolin). (0287X089-22)

U.S. Department of Agriculture scientists are searching for ways to cut disadvantages U.S. wool producers face when competing against imported wool.

Most American farmers and ranchers breed and raise sheep primarily for meat, unlike foreign producers for whom wool quality is number one. Because American raw wool is a byproduct and usually receives less care, it can contain sheep urine stains or residues such as straw, grass, and seeds, or black hairs that look like ballpoint pen streaks in lightly colored fabrics.

Such problems hurt the reputation of American raw wool and hinder the domestic grower from receiving a price that is competitive with imported—mainly Australian—wool.

USDA scientists are trying to overcome these problems so the U.S. product can compete more effectively, says William N. Marmer, lead scientist for wool research at USDA's Agricultural Research Service facility in Philadelphia, PA.

Four people—Marmer, chemist Paul Magidman, Christopher Carr (a foreign research associate who has worked in Australia), and a student trainee—are working on the wool research, aided by microscopists, engineers, and a materials scientist. Studies being undertaken to improve quality include:

• Depigmenting dark-colored wool hairs. The dark hairs are caused by a pigment in wool called melanin, the same pigment that gives human hair and skin their color. Textile mills remove these hairs manually or lighten the color by bleaching.

"One of our goals is to find new methods for bleaching pigmented wool that won't hurt its quality," Marmer says.

• Removing urine stains. Since sheep are raised primarily for meat, not much care is taken to shear off stained raw wool before it is sent to textile mills. Urine's yellow stain cannot be washed out with current methods.

"We're looking at new bleaching methods for urine-stained wool," Marmer says.

• Taking out vegetable matter. If weed seeds, burrs, and dried grass aren't removed, he says, they can wind

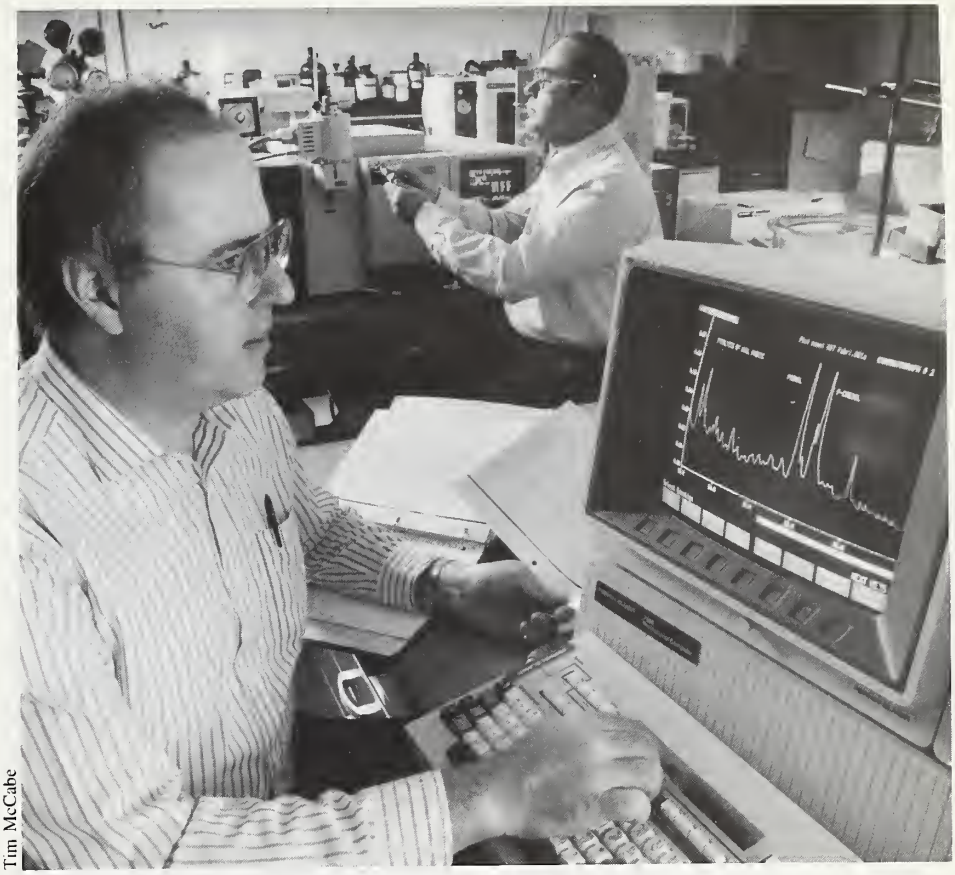
up in wool fabric "and you have trash woven into your wool garment."

Textile mills now remove the particles by carbonization, in which sulfuric acid is used to char the straw so that it falls out when it is run through rollers at the mill. But, like bleaching, this process weakens the wool and affects what is known as the wool's "hand" or feel.

"We are working with our engineering staff to see if we can find an alternative. Right now, we're testing a high-pressure steam process called explosion-puffing, examining the effects on wool and its accompanying vegetable matter," Marmer says.

"USDA scientists are trying to overcome problems with U.S. wool so it can compete more effectively."

William N. Marmer, wool researcher at the ARS Eastern Research Center, Philadelphia, PA.



Tim McCabe

Chemists Marmer and Paul Magidman (background) analyze wool constituents to determine effects of chemical and physical treatments. (0287X092-13)

• Removing grease. Only about half the weight of raw wool is wool fiber. Much of the remaining weight is grease, which is removed by scouring. Most of that removed ends up as unrecovered waste, although some is refined to lanolin for cosmetics and other products.

Marmer says that scientists are looking into extraction procedures using carbon dioxide compressed at high temperature to a liquidlike supercritical fluid.

Scientists at the ARS Northern Research Center in Peoria, IL, have shown that the fluid is a good solvent for vegetable oils and, unlike many commonly used solvents, is nontoxic and nonpolluting.

"We want to see if it'll remove wool grease and also separate the grease into more useful components," Marmer says.

Frank X. Werber, the ARS national program leader for textiles and fibers, says the research could eventually help reverse a trend of declining U.S. wool production and rising imports. In 1970, domestic production of clean wool, excluding grease weight, was 88 million pounds; by 1985, it had dropped to 46 million pounds, according to USDA statistics. Imported clean wool, coarse and fine grades, increased from 27 million pounds in 1974 to 80 million in 1985.

Making matters worse for wool growers, artificial fibers such as polyester and nylon have taken a large share of the textile market since World War II, not only in clothing, but also in carpeting and upholstery.

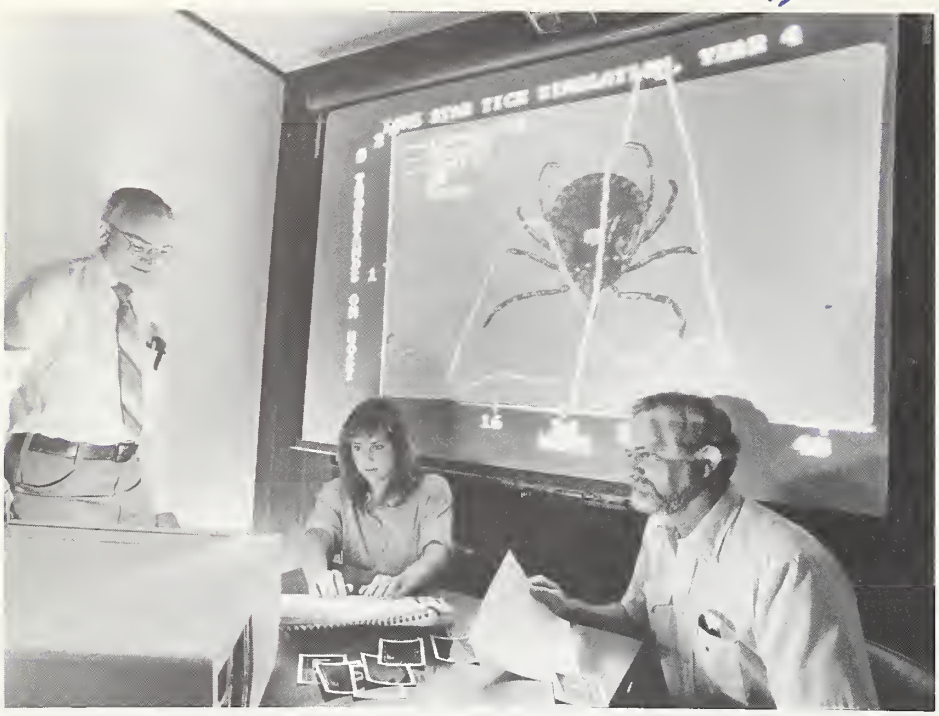
"The problems are tough, and previous efforts to solve them have had limited success," Werber says. "But they hurt the industry, and we think our scientists can make important progress." — By **Sean Adams**, ARS.

William N. Marmer is at the USDA-ARS Animal Biomaterials Research Unit, Eastern Research Center, 600 Mermaid Lane, Philadelphia, PA 19118. ♦

Tim McCabe

Chemist Christopher Carr monitors bleaching reactions on samples of urine-stained wool. (0287X093-11)

Insect Fighters Gear for War



At Gainesville, FL, entomologist Gary Mount (left), computer programmer Patricia Jones, and agricultural engineer Dan Haile use a video projector hooked to a computer to view graphs of seasonal populations of lone star tick living on white-tailed deer and other wildlife. (0786X910-11)

Ticks, mosquitoes, roaches, and other insects, as well as diseases they transmit, might one day be defeated by researchers armed with personal computers.

Entomologist Gary A. Mount and engineer Danel G. Haile with USDA's Agricultural Research Service, Gainesville, FL, have already developed a growth-simulation and control computer model for the lone star tick, a blood-sucking pest that infests recreational areas and ranches, mostly in the South.

"It's still experimental, but so far, tests have verified that the population predictions and control recommendations are correct," Mount says.

Work has begun on models for other ticks, mosquitoes, and mosquito-related diseases like malaria, yellow fever, and dengue fever, says Ralph A. Bram, the agency's national leader for research on insects affecting people and animals.

"Our scientists will also be targeting fire ants, roaches, flies, and cattle grubs in the future. We see possibilities for developing control strategies for at least those insects that are the worst pests to agriculture and humans in this country," he says.

Each year, Americans reportedly spend more than $3 billion to rid their homes, backyards, and campsites of ticks, roaches, mosquitoes, and other insects. Many of these pests, together with diseases they can transmit, pose a health threat. And agricultural pests also cost farmers and ranchers $20 billion annually in losses and for control.

To predict a future population of one of these expensive pests, the scientists instruct the computer to compare the insect—its life history and survival needs—with information about weather and habitat in the target area.

The National Oceanographic and Atmospheric Administration supplies nationwide weather data, while research at Gainesville and worldwide yields information about insect habitat, biology, and control.

Mount and Haile put this information into their lone star tick forecasting program.

They told the computer that the pest thrives in the woods, with high humidity, warm temperatures, and plenty of white-tailed deer for hosts. This affinity for the woods makes the tick a nuisance for campers.

"Sometimes a family sets up camp and then, 2 hours later, pulls up the stakes and leaves—just because of the number of ticks that attack them for a blood meal," Mount says. The tick is also a potential carrier of Rocky Mountain spotted fever and other diseases.

The scientists tested their tick program in three different areas of eastern Oklahoma. Its predictions agreed with actual field counts of ticks for 3 years in a row.

When asked what the population would be after a year in Peoria, IL, where the tick does not occur, the computer answered almost zero, finding from its database that Peoria does not have high enough temperatures.

As for its ability to determine the ideal control strategy, the model is being tested in a cooperative project with the Tennessee Valley Authority at campgrounds in Land Between the Lakes in Kentucky and Tennessee.

In these tests, researchers put three possible controls for the tick into the model: pesticides, controlled burning of plants the ticks live under part-time, and fencing off or relocating white-tailed deer, the tick's first choice as a host.

They also described to the computer, in a very general way, how ticks respond to each kind of control.

The computer then decided how and when to use each method to control ticks in the cheapest, safest, and most efficient way.

The model forecast that after a year of total exclusion of deer, the tick population would decrease 95 percent. At Land Between the Lakes, where this was tested, it decreased 98 percent, he says.

Future programs for other pests will work in a similar manner.

Haile says, "Officials may do in 10 minutes what it normally takes years to do in nature: observe long-term population changes of pests under various control strategies. And all they would need are the program on a floppy disk and a personal computer." — By **Jessica Morrison,** ARS.

Gary A. Mount is with the USDA-ARS Insects Affecting Man and Animals Research Laboratory, P.O. Box 14565, Gainesville, FL 32604. ♦

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Putting the Soft Touch on Cherry Trees

"The operation was a success but the patient died," says USDA Agricultural Research Service engineer Galen K. Brown, referring to mechanical harvesting techniques which are cutting the productive life of Michigan's cherry orchards from 30 to less than 20 years.

Research by ARS and Michigan State University researchers in East Lansing focuses on recognizing and minimizing the damage machines can do to cherry tree trunks.

While mechanical harvesting gave Michigan's sweet and sour cherry business a shot in the arm in the 1960's, the change from hand-picking to mechanical harvesting also brought a serious problem that can't be overlooked today.

Mechanical shakers pick 98 percent of Michigan's sweet and sour cherry trees. Recent tests have shown that over two-thirds of young trees have trunk damage after the first 3 years of mechanical harvesting. "If we want orchards to last 30 years, we have to reduce the damage," says Brown.

Trees—both young and old—are being overshaken. Growers often shake trees four or five times for a few seconds at a time. Brown recommends replacing the several short shakes with one continuous 5- to 10-second shake until the cherries drop onto the canvas or catcher below.

Trunk shakers designed for full-grown trees are being used on young trees that are easy to damage. Some commercial shakers briefly apply excessive movement and force to the bark when the machines start and stop. The research team identified ways to keep this from happening and in the process invented a controllable shaker which may soon be commercially adopted.

To reduce the damage to young trees caused by currently used shakers, Brown and colleagues, designed a new clamp pad system that allows safely harvesting young trees that have trunks as small as 1.5 inches in diameter.

Besides designing a new pad system, the scientists have found better ways to use existing ones. For example, using nitrile-covered thin belting over the pads, silicone lubricant on the nitrile surfaces, and less clamping pressure reduces the forces that loosen bark during shaking.

Bob Bjork

Trunk shaker harvests cherries in Michigan. (0874X1387-12)

"Some commercial clamp pads applied more than five times the pressure that the bark can stand without damage," says Brown, who recommends applying no more than 150 pounds per square inch to the bark of young sweet or sour cherry trees.

Cracks and broken bark are obvious signs of trunk damage, but damage can be hidden too. Cells rupture in the cambium layer where xylem cells become wood and phloem cells develop into bark.

Diseases and insects, such as the American plum borer, a serious pest in Michigan, can enter through cracks that may not be seen until a year after harvest. The borer gets into young tree tissue, reproduces, and the entire colony chews their way around the tree, says ARS plant pathologist Clyde L. Burton.

Wet weather also makes trees more susceptible to bark damage. "It's unfortunate that cherries are harvested in June and July when tree cells are regenerating and most vulnerable," says Brown. He recommends that growers shut off irrigation at least 2 weeks before harvest, then resume after harvest.

Steps to reduce harvest-inflicted injuries can be taken now. By modifying equipment, training personnel, and applying good management techniques, growers can extend the productive life of an orchard by 10 years. "Our goal is to be able to harvest cherry trees with no injury at all," says Brown. — By **Linda Cooke**, ARS.

Galen K. Brown and Clyde L. Burton are in USDA-ARS Fruit and Vegetable Research, 208 A.W. Farrall Hall, Michigan State University, East Lansing, MI 48824. ♦

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Smart Fabrics Watch the Temperature

Clothing of the future may actually sense when the air temperature is dropping and release heat stored in the fabric to keep the wearer comfortable. The heat-transfer process would be reversible so that in hot weather the clothing would feel cool to the skin.

According to textile experts with USDA's Agricultural Research Service, experimental fabrics are already here that not only respond to temperature changes but also have less shrinkage, improved moisture absorbency, and better antistatic behavior.

"We're developing temperature-adaptable textiles with built-in chemical thermostats to warm you when you're cold and cool you when you're hot," says Tyrone L. Vigo, a chemist for ARS in New Orleans, LA.

Vigo and his colleague, chemist Joseph S. Bruno, have named the new treatment Polytherm because of its ability to make fabrics temperature adaptable.

Vigo says Polytherm works on most natural and synthetic fabrics, such as wool and cotton and their blends, fiberglass, and acrylics.

The researchers treated fabrics with a class of inexpensive chemicals called polyethylene glycols—PEG's for short. PEG's can be chemically attached to most types of fibers by a process similar to that used to make permanent press (durable-press) fabrics.

"The modified fabrics store and release heat at various temperatures by the reversible melting and crystallization of PEG's," Vigo says.

In a cooperative project between ARS and the U.S. Air Force, Vigo and Bruno will evaluate physical and chemical techniques to produce temperature-adaptable gloves for use under Arctic conditions.

"One of Polytherm's major attributes is that its thermostat can be set to kick on at a certain temperature, depending on the PEG it's treated with," Vigo says. For example, when the air temperature reaches 70°F to 80°F, the treated fabric counteracts the higher temperatures by absorbing body heat, thereby providing a cooling effect. When the air temperature drops below 40°F, the same fabric would release heat to the body.

How much energy treated fabrics will store and release depends on the kind of fiber, the chemical applied, and the amount applied. "A 50 to 100-percent enhancement of heat

Jack Dykinga

"Polytherm" T-shirt is displayed by chemists Joseph Bruno (left) and Tyrone Vigo. In foreground are gloves and other products also made with fabrics specially treated to give off or absorb heat to keep the wearer comfortable. (0287X10326)

New Ways to Leaner Meat

As more consumers prefer leaner meat, U.S. Department of Agriculture scientists are working on new ways to trim unwanted fat from meat before it reaches the dinner table.

"Producing animals with lean meat that has flavor and tenderness is our goal," says Roger Gerrits, National Program Staff leader for animal production, USDA Agricultural Research Service. "But you can't remove all the fat, because it's an important component in meat flavor."

A long-standing way of reducing fat is to breed leaner animals, he says. Agency scientists at Clay Center, NE, improve cattle through crossbreeding and genetic selection, while researchers at Beltsville, MD, are using genetic selection to reduce the amount of fat in pork.

Leaner meat has been a goal of animal scientists since the 1950's, and breeding has been the focus of research. "Consumers want meat with less fat, and farmers don't want to spend money producing fat that consumers don't want," Gerrits says. "Producing leaner animals makes economic as well as nutritional sense.

Consumption of red meat—incuding beef, pork, lamb, and veal—has fluctuated and generally declined over the last 15 years. Between 1970 and 1985, per capita consumption, in retail weight, of these red meats dropped from 151.6 pounds to 144.5, according to USDA statistics.

Consumption of leaner meats such as turkey, chicken, and fish increased over that 15-year period. Per capita turkey consumption, in retail weight, went up from 8 to 12 pounds a year, while consumption of broilers increased from 36.8 pounds in 1970 to 54.9 in 1985, Department figures show.

Increased awareness by consumers of diet health concerns and the fat content of meat has contributed to these trends and has prompted agency scientists to study fat formation in meat and poultry and its role in the human diet.

"We've come a long way in reducing fat, but we still have several new areas to explore," Gerrits says.

Among the current research projects:

- Investigating enzymes that help break down and store fat. There is still much to learn about how animals, such as cattle, pigs, poultry, and sheep, convert feed to fat. If scientists can learn how these enzymes work, they may be able to control where, and how much, fat is formed.
- Analyzing fat in the fetus. One avenue is using biochemical methods to determine how cells are formed and electron microscopy to determine the size and number of fat cells in chicken and pig fetuses. Scientists may be able

absorption or release is probably a realistic goal," he says.

"Polytherm can have many potential applications," Vigo says, "from a variety of apparel items for work, dress, and sports to household furnishings like carpets and drapes. It may also be used by biomedical, aerospace, and other specialty industries, such as insulated building products."

It's not anticipated that the PEG's will cause any allergic reaction, Vigo says, but safety testing will have to be done by commercial companies interested in marketing Polytherm products.

Vigo and colleagues have been experimenting with temperature-adaptable fabric since 1981 and have found a way to partially overcome a shortcoming: The treated fabrics could not withstand laundering or exposure to moisture.

Working at the agency's Southern Research Center in New Orleans, they have made the treatment more durable, by chemically binding PEG's to fabrics. Vigo says fabrics with chemically attached PEG's retain their thermal properties for up to 10 home launderings. He and Bruno are looking for long-term durability.

Vigo says, "We still have a lot to learn about these fabrics. For instance, we don't know just how much chemical is needed to produce a pronounced retention or release of heat. Nor do we know how long the thermal effect would last in different environments."

To answer some of these questions, he and Bruno are evaluating treated fabrics for their heat-transfer behavior by a variety of techniques such as thermography, which uses a colorcoded temperature profile to determine heat loss and gain.

"Textile manufacturers and users of specialty fabrics are becoming increasingly interested in the research," Vigo says. Patents are pending on the processes the research team has developed. — By **Hank Becker,** ARS.

Tyrone L. Vigo and Joseph S. Bruno are in the USDA-ARS Textile Chemistry Unit, Southern Research Center, 1100 Robert E. Lee Boulevard, New Orleans, LA 70179. ♦

to control fat in these animals if they can identify how genetics, nutrition, or hormone levels influence the composition of the animal.

• Inserting genes for leaner breeds. Scientists are identifying marker genes associated with fat and other characteristics in animals. These genes could be removed from one animal species and inserted into another.

• Studying how growth hormone may help the animal make lean meat while reducing fat. Animal physiologist Joan Eisemann, in studies at Clay Center, is trying to find out how this hormone changes a steer's metabolism and affects the quality of its meat.

Preliminary research indicates that recently developed synthetic growth hormones can reduce fat and improve the efficiency of meat production.

• Using light to stimulate cattle and sheep to produce growth hormones. Bruce Schanbacher, an animal physiologist at Clay Center, has found that day-night patterns affect how Suffolk sheep produce hormones. He says hormone levels accounted for 29 percent of the difference in growth and 40 percent of the difference in fat. If scientists can use light to stimulate the hormones, he says, "we might be able to better convert nutrients in feed into lean meat, instead of fat."

• Introducing foreign animals that have less fat. For the first time in the United States, Kreg Leymaster will be breeding a sheep from the Netherlands called Texel. It may be an excellent source of lean meat, either inbred or crossed with domestic breeds.

• Predicting obesity, and increased fat, by using hormone and enzyme markers. Animal physiologist Gary J. Hausman at Athens, GA, can predict if pigs will be lean or fat before they are born by detecting these markers. One, called lipoprotein lipase, controls the movement of fat molecules from the blood to fatty tissue. Another marker, swine growth hormone, controls fat metabolism and growth rate.

• Studying pigs' eating habits. Pigs don't "pig out," despite popular misconceptions. To increase weight gain of livestock, animal nutritionist Jerome C. Pekas at Clay Center force-fed pigs a semiliquid diet of 20 percent more food than they would normally consume. Compared with litter mates who were not force-fed but given all the feed they wanted, force-fed pigs gained 40 percent more weight, with the amount of preferred lean tissue improved.

• Genetically selecting pigs for their efficiency of producing lean tissue. Animal geneticist Ben Bereskin, in Beltsville, has been breeding swine for five generations to reduce fat.

• Lowering fat in chickens. Animal nutritionist Robert W. Rosebrough, also at Beltsville, found that 6-day-old chicks, placed on a restricted diet, had 25 percent less abdominal fat when they were 8 weeks old and ready for market. They stayed on the diet for 6 days, then returned to a normal diet to gain weight as quickly as possible.

Bob Bjork

USDA inspectors grade beef in a Nebraska packing plant. (0776X929-30)

• Looking at chicken fat cells. Animal physiologist Aubrey Cartwright is studying broilers at Georgetown, DE. As broiler size has increased over the last 30 years, fat deposition has gone up 50 percent. The goal is to find out why "so we can produce leaner chickens." — By **Sean Adams,** ARS.

Roger J. Gerrits is with the USDA-ARS National Program Staff, Room 209, Bldg. 005, BARC-West, Beltsville, MD 20705. ♦

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PATENTS

Irradiating Corn for Alcohol Production

Treating corn or other cereal grains with gamma radiation eliminates the costly cooking of the grain mash prior to making alcohol. Mash is normally cooked to rupture the molecular structure of the grain grits. This turns it into a jelly with the starch exposed for later enzyme action that converts it to a fermentable sugar.

Irradiation accomplishes the same thing by cleaving the starch molecules. And in all experiments comparing heat gelatinization to irradiation, the alcohol yield was about the same.

For technical information, contact Youn W. Han, USDA-ARS Southern Research Center, P.O. Box 19687, New Orleans, LA 70179. *Patent No. 4,631,258, "Irradiation Alcohol Fermentation Process."* ♦

Sweetpotato Weevil Pheromone

Add sweetpotato weevils to the growing list of pests that pheromones (chemical attractants) can be used to monitor and control.

The major female-produced pheromone of the sweetpotato weevil has been isolated, identified, and successfully synthesized.

Identification was particularly difficult because the pheromone compound's chemical structure is different from all other known pheromones and is produced in minute amounts.

In field tests, the synthetic pheromone attracted as many males to traps as did the natural scent. It offers farmers a sensitive lure to help monitor a devastating pest that is hard to detect otherwise because the larvae feed underground and the adults feed at night.

The work was a team effort of Robert R. Heath, James A. Coffelt, Fredrick I. Proshold, Philip E. Sonnet, and James H. Tumlinson, the research leader at the laboratory.

For technical information, contact Robert R. Heath, USDA-ARS Insect Chemistry Research, P.O. Box 14565, Gainesville, FL 32604. *Patent Application Serial No. 06/879,696, "(Z)-3-Dodecen-1-ol (E)-2-Butenoate and Its Use in Monitoring and Controlling the Sweetpotato Weevil."* ♦

Temperature-Adaptable Fabrics

See "Smart Fabrics Watch the Temperature," p. 14, for information on *Patent Application Serial No. 06/818,567, "Temperature Adaptable Textile Fibers and Method of Preparing Same."* ♦

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